GDP-0005

SSC

Chapter 0524 STANDARDS FOR RADIATION PROTECTION

0524-01 POLICY AND OBJECTIVE

011 It is policy of ERDA that

a. Radiation protection standards applicable to ERDA and ERDA contractor operations not subject to Nuclear Regulatory Commission (NRC) licensing be established to protect the general public, ERDA, and ERDA contractor personnel and property.

b. ERDA and ERDA contractor operations be conducted in a manner to assure that radiation exposure to individuals and population groups is limited to the lowest levels technically and economically practicable.

012 Objective

To establish radiation protection standards for ERDA and ERDA contractor operations based upon the recommendations of the Federal Register Council, Environmental Protection Agency (EPA), and the National Council on Radiation Protection and Measurements.

0524-02 APPLICABILITY

This chapter and its appendix are applicable to Headquarters divisions and offices, field organizations, and ERDA contractors who may be exposed to ionizing radiation resulting from ERDA and ERDA contractor operations. This chapter and its appendix apply to routine operations. They do not apply to certain specific activities such as those essential to the national security which may require criteria for planning or operations involving exposure guidelines for uncontrolled areas different from the basic standards contained herein. For these activities, the guidelines of this chapter will be applied insofar as possible and exceptions may be developed in coordination with the Director, Division of Safety, Standards, and Compliance, in accordance with 031(b) or as may be set forth in other manual chapters.

0524-03 RESPONSIBILITIES AND AUTHORITIES

031 The Director, Division of Safety, Standards, and Compliance

a. Develops, or promotes the development of, radiation protection standards and policies relating to ERDA and ERDA contractor operations.

b. Approves or disapproves each proposed exception to the radiation protection standards established by this chapter.

c. Appraises the performance of ERDA field offices and upon request, and when circumstances warrant, appraises ERDA contractors as set forth in chapter 0504, "Operational Safety Program Appraisals."

d. Renders interpretation of the requirements of this chapter.

032 Heads of Divisions and Offices, Headquarters, assure that employees under their jurisdiction comply with the provisions of this chapter.

033 Heads of Field Organizations*

a. Assure that ERDA and ERDA contractor personnel and the general public are protected against unnecessary radiation exposure and comply with the provisions of this chapter.

b. Request and justify specific exceptions for planned or anticipated deviations from the requirements of this chapter.

c. Review and approve emergency plans for rescue and recovery operations.

d. Act, where immediate decisions and actions are required, on requests for exceptions to the requirements of this chapter and immediately report and justify such action to the Division of Safety, Standards, and Compliance. Contractors may be authorized to take all appropriate measures in emergency situations. See appendix 0524, Part V, "Guidance for Emergency Exposure During Rescue and Recovery Activities."

*For purposes of this chapter, the Director, Division of Naval Reactors, will assume the same responsibility as the managers of field offices for his program activities.

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PART I
DEFINITIONS, EXCEPTIONS, AND REFERENCES

A. DEFINITIONS

1. ERDA Contractor

Any ERDA prime contractor or subcontractor exempt from, or not subject to, NRC licensing provisions other than 10 CFR Part 115, "Reactors," but subject to the contractual provisions of ERDA-PR 9-7.5004-12 or modifications thereof.

2. Controlled Area

Any area, access to which is controlled for purposes of protection of individuals from exposure to radiation and radioactive materials.

3. Dose Commitment

The dose equivalent (rems) received by specified organs during a period of one calendar year which was the result of an uptake of a radionuclide by a person occupationally exposed.

B. EXCEPTIONS TO CHAPTER REQUIREMENTS

Approval of the Director, Division of Safety, Standards, and Compliance, must be obtained for any deviations from the requirements of this chapter or use of radiation protection standards different from those provided in the appendix except in emergency situations where immediate decisions and actions are required.

C. REFERENCES

1. Chapter 0525, "Occupational Radiation Exposure Information."
2. Chapter 0545, "Nuclear Accident Dosimetry Program."
3. Chapter 6301, "Facilities General Design Criteria."

PART II
INDIVIDUALS IN CONTROLLED AREAS

A. RADIATION PROTECTION STANDARDS FOR EXTERNAL AND INTERNAL EXPOSURES

Type of Exposure	Exposure Period	Dose Equivalent (Dose or Dose Commitment* (rem))
Whole body, head and trunk, gonads, lens of the eye†, red bone marrow, active blood forming organs.	Year	5‡
	Calendar Quarter	3
Unlimited areas of the skin (except hands and forearms). Other organs, tissues, and organ systems (except bone).	Year	15
	Calendar Quarter	5
Bone.	Year	30
	Calendar Quarter	10
Forearms.§	Year	30
	Calendar Quarter	10
Hands§ and feet.	Year	75
	Calendar Quarter	25

*To meet the above dose commitment standards, operations must be conducted in such a manner that it would be unlikely that an individual would assimilate in a critical organ, by inhalation, ingestion, or absorption, a quantity of a radionuclide(s) that would commit the individual to an organ dose which exceeds the limits specified in the above table.

†A beta exposure below a maximum energy of 700 Kev will not penetrate the lens of the eye; therefore, the applicable limit for these energies would be that for the skin (15 rem/year).

‡In special cases with the approval of the Director, Division of Safety, Standards, and Compliance, a worker may exceed 5 rem/year provided his/her average exposure per year since age 18 will not exceed 5 rem per year.

§All reasonable effort shall be made to keep exposures of forearms and hands to the general limit for the skin.

B. PROCEDURAL REQUIREMENTS

1. Restrictions

a. An individual under age 18 shall neither be employed in, nor allowed to enter, controlled areas in such manner that he will receive doses of radiation in amounts exceeding one-tenth the standards in A., above.

b. Students under age 18 exposed to radiation during educational activities shall not exceed 0.1 rem/year. This exposure shall be considered a part of the 0.5 rem/year limit for workers under age 18 and not supplemental to it.

2. Combining Internal and External Dose

Current year whole-body internal dose commitment from radionuclides for which the whole body is the critical organ must be combined with the external whole-body dose. Where both the external penetrating dose and internal dose to critical organ are known, they shall be combined for that organ.

3. Emergency or Accidental Exposure

Radiation doses received in emergency actions or accidental situations will be chargeable to the radiation exposure status of the individual. However, the decision as to whether the individual will continue to work in a radiation area will be made on a case-by-case basis by plant management in accordance with the advice of the plant health physicist and occupational medical departments and subject to the approval of the ERDA field office manager.

4. Monitoring Requirements

Monitoring is required where the potential exists for the individual to receive a dose or dose commitment in any calendar quarter in excess of 10 percent of the quarterly standards stated in A. and B.1.b., above. Monitoring requirements as specified for the following conditions shall include:

a. External radiation—personnel monitoring equipment for each individual.

b. Internal radiation—periodic (monthly, quarterly, annually, etc.) bioassay analysis or in vivo counting or evaluation of air concentrations to which the individual is exposed or a combination of all methods.

5. Methods of Estimating Dose Commitment

Methods of estimating dose commitment to the organ of interest should be suitable to the existing conditions and consistent with assumptions and recommendations of the Federal Radiation Council (FRC), the National Council on Radiation Protection and Measurements (NCRP), and the International Commission on Radiological Protection (ICRP).

C. CONCENTRATION GUIDES (CGs)

1. Air

CGs in annex A, table I, column 1, were derived for the most part from the yearly standards in A., above (assume a 40-hour workweek). They should be used in evaluating the adequacy of health protection measures against airborne radioactivity in occupied areas.

2. Water

The CGs in annex A, table I, column 2, are applicable to the discharge of liquid effluents to sanitary sewerage systems (see part III, E.). Drinking water concentrations in restricted areas shall be maintained within the CGs specified in table II, column 2.

PART III
INDIVIDUALS AND POPULATION GROUPS IN UNCONTROLLED AREAS

A. RADIATION PROTECTION STANDARDS FOR EXTERNAL AND INTERNAL EXPOSURE

Type of Exposure	Annual Dose Equivalent or Dose Commitment (rem)* Based on dose to individuals at points of maximum probable exposure	Based on an average dose to a suitable sample of the exposed population†
Whole body, gonads, or bone marrow	0.5	0.17
Other organs	1.5	0.5

*In keeping with ERDA policy on lowest practicable exposure, as expressed in chapter 0524-011b., exposures to the public shall be limited to as small a fraction of the respective annual dose limits as is practicable.

†See Par. 5.4, FRC Report No. 1, for discussion on concept of suitable sample of exposed population.

B. MONITORING REQUIREMENTS

To assure that doses to the public are maintained at the lowest practicable level consistent with dose standards set forth in A., above, effluents, environmental media, and other parameters shall be monitored and documented in accordance with ERDAM 0513.

C. CONCENTRATION GUIDES (CGs)

1. CGs in annex A, table II, were derived for the most part from the dose standards for individuals in A., above (assume 168 hours of exposure per week). These guides shall be reduced by a factor of three when applied to a suitable sample of the exposed population. Where transient exposures can be calculated, the CGs other than those in annex A, table II, may be used to evaluate compliance with the dose commitment standard.

2. There may be situations where it is not feasible or desirable to evaluate the exposure of individuals and samples of exposed populations to effluents to assure compliance with standards in A., above. In those cases, effluent releases to uncontrolled areas shall be such that average concentrations of radioactivity at the point of release are as low as practicable. The point of release shall be considered to be the point at which the effluents pass beyond the site boundary. Radioactivity concentrations may be averaged over periods up to 1 year.

D. FURTHER LIMITATIONS ON EFFLUENT DISCHARGES

In any situation in which the effluents discharged by one or more activities of ERDA, ERDA contractors, or others cause exposure to approach the standards specified in A., above, appropriate effluent discharge limits may be set for these operations. In such cases, the manager of the field office may take the necessary corrective action if all activities concerned are within his/her area of responsibility. Otherwise, each case will be referred to the Director, Division of Safety, Standards & Compliance, for appropriate action including, where appropriate, coordination with actions taken by the Nuclear Regulatory Commission under 10 CFR 20.106(e).

E. DISCHARGE TO SANITARY SEWERAGE SYSTEMS

1. Effluents may be discharged to public sanitary sewerage systems provided:

a. The quantity of radioactivity released in any 1 month, if diluted by the average monthly quantity of water released by the installation, will not result in an average concentration exceeding the CG in annex A, table I, column 2.

b. The radiation protection standards in A., above, are not exceeded.

2. Concentrations or quantities of radioactive materials greater than those specified in 1.a. and b., above, may be released to chemical or sanitary sewerage systems owned by the Federal Government provided the standards in A., above, are not exceeded in uncontrolled areas.

PART IV
QUALITY FACTORS TO BE APPLIED IN DETERMINING REM EXPOSURE

The exposure standards specified in this appendix are expressed in terms of rem, which implies that the absorbed dose (expressed in rads) should be multiplied by an appropriate weighting factor (quality factor (QF)). The QFs to be used for determining neutron exposures from known energies are provided in the following table:

SPECIFIC PROTECTION CONCEPTS OR STANDARDS

Mean quality factors, $\overline{QF}$,* and values of neutron flux density which in a period of 40 hours results in a maximum dose equivalent of 100 mrem

Neutron Energy	$\overline{QF}$	Neutron Flux Density
MeV		$cm^{-2}\ s^{-1}$
2.5×10^{-8} (thermal)	2	680
1×10^{-7}	2	680
1×10^{-6}	2	560
1×10^{-5}	2	560
1×10^{-4}	2	580
1×10^{-3}	2	680
1×10^{-2}	2.5	700
1×10^{-1}	7.5	115
5×10^{-1}	11	27
1	11	19
2.5	9	20
5	8	16
7	7	17
10	6.5	17
14	7.5	12
20	8	11
40	7	10
60	5.5	11
1×10^{2}	4	14
2×10^{2}	3.5	13
3×10^{2}	3.5	11
4×10^{2}	3.5	10

*Maximum value of $\overline{QF}$ in a 30-cm phantom.

PART V

GUIDANCE FOR EMERGENCY EXPOSURE DURING RESCUE AND RECOVERY ACTIVITIES

A. PURPOSE

The emergency action guidance promulgated in this part provides instructions and background information for use in determining appropriate actions concerning the rescue and recovery of persons and the protection of health and property during periods of emergency.

B. GENERAL CONSIDERATIONS

1. The problem of controlling exposure to radiation during rescue and recovery actions is extremely complex. Performing rescue and recovery operations requires the exercise of prompt judgment to take into account multiple hazards and alternate methods of accomplishment. Sound judgment and flexibility of action are crucial to the success of any type of emergency actions. Although the guiding principle is to minimize the risk of injury to those persons involved in the rescue and recovery activities, the control of radiation exposures should be consistent with the immediate objective of saving human life, the recovery of a deceased victim, and/or the protecting of health and saving of property.

2. To preclude the possibility of unnecessarily restricting action that may be necessary to save lives, these instructions do not establish a rigid upper limit of exposure but rather leave judgment up to persons in charge of emergency operations to determine the amount of exposure that should be permitted to perform the emergency mission.

3. The official in charge must carefully examine any proposed action involving further radiation exposure by weighing the risks of radiation insults, actual or potential, against the benefits to be gained. Exposure probability, biological consequences related to dose, and the number of people involved are the essential elements to be evaluated in making a risk determination.

4. These instructions recognize that accident situations involving the saving of lives will require separate criteria from those of actions required to recover deceased victims or to save property. In the latter instances, the amount of exposure expected to be received by persons should be controlled as much as possible within occupational limits.

C. EMERGENCY SITUATIONS

Specific dose criteria and judgment factors are set forth for the three categories of risk-benefit considerations, i.e., actions involving the saving of human life, the recovery of deceased victims, and the protection of health and property.

1. Saving of Human Life

a. Attempts to rescue victims of a nuclear incident should be regarded in the same context as any other emergency action involving the rescue of victims, regardless of the type of hazard involved.

b. Where there is reasonable expectation that an individual is alive within the affected area, the course of action to be pursued should be determined by the person onsite having the emergency action responsibility.

c. The amount of exposure for this type of emergency action shall be determined by the person onsite having the emergency action responsibility. He should immediately evaluate the situation and establish the exposure limit for the rescue mission accordingly. His judgment should be based upon:

(1) Evaluation of the inherent risks by considering:

(a) The reliability of the prediction of radiation injury. This reliability cannot be any greater than reliability of the estimation of the dose. Therefore, consideration should be given to limits of error associated with the specific instruments and techniques used to estimate the dose rate. This is especially crucial when the estimated dose approximates 100 rems or more.

(b) The exposure expected in performing the action shall be weighed in terms of the effects of acute external wholebody exposure and entry of radioactive material into the body.

(2) Current assessment of the degree and nature of the hazard, and the capability of reducing inherent risk from that hazard through appropriate mechanism such as the use of protective equipment, remote manipulation equipment, or similar means.

d. In the course of making a decision to perform the action, the risk to rescue personnel should be weighed against the probability of success of the rescue action.

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e. Any rescue action that may involve substantial personal risk should be performed by volunteers, and each emergency worker shall be advised of the known or estimated extent of such risk prior to participation.

2. Recovery of Deceased Victims

a. Accident situations involving recovery of deceased victims require criteria separate from those for saving lives. Since the element of time is no longer a critical factor, the recovery of deceased victims should be well planned. The amount of radiation exposure received by persons in recovery operations shall be controlled within existing occupational exposure guides.

b. In those situations where the bodies are located in areas inaccessible because of high direct radiation fields, and where the recovery mission would result in exposure in excess of occupational exposure standards contained in this appendix, special remote recovery devices should be used to retrieve the bodies.

c. In special circumstances where it is impossible to recover bodies without the entry of emergency workers into the area, the individual in charge of the recovery mission may determine it necessary to exceed the occupational exposure standards contained in this appendix. The planned exposures of an individual participating in the recovery should not exceed 12 rem total for the year or 5 (N-18), whichever is the more limiting.

3. Protection of Health and Property

a. Where the risk (probability and magnitude) of the radiation hazard either bears significantly on the state of health of people or may result in loss of property, so that immediate remedial action is required, the following criteria should apply:

(1) When the person in charge of emergency action onsite deems it essential to reduce a hazard potential to acceptable levels or to prevent a substantial loss of property, a planned exposure up to, but not to exceed, 12 rem for the year may be received by individuals participating in the operation.

However, the person in charge of emergency action at the incident scene may elect, under special circumstances, to waive these limits and permit volunteers to receive an exposure up to, but not to exceed, 25 rem.

(2) Where the potential risk of radiation hazard following the nuclear incident is such that life would be in jeopardy, or that there would be severe effects on health of the public or loss of property inimicable to the public safety, the criteria for saving of human life shall apply.

PART VI

GUIDANCE ON MAINTAINING EXPOSURES TO AS LOW AS PRACTICABLE

A. INTRODUCTION

Maintaining radiation exposures to as low as practicable and within the guidelines provided in ERDAM 0524 is an ERDA management commitment. Assurance that worker and public exposures do not exceed the exposure guidelines (e.g., 3 rem/q, 5 rem/y for radiation workers) is, in itself, insufficient because ERDA policy (chapter 0524-011) states in part that operations shall be "conducted in a manner to assure that radiation exposure to individuals and population groups is limited to the lowest levels technically and economically practicable." The guidelines contained herein suggest several factors to consider in each operation to assure compliance with ERDA policy. They are by no means exhaustive. Other criteria should be added as particular situations dictate. Basic to following these guidelines is the premise that exposures can be maintained as low as practicable through considerations in the design or modification to a facility and equipment, reducing the errors in radiation exposure assessments through the application of state-of-art instrumentation maintenance and calibration; and by the institution of appropriate procedures and training.

B. CONSIDERATIONS TOWARD MAINTAINING RADIATION EXPOSURES AS LOW AS PRACTICABLE

When applying the following guidelines, changes in processes or modifications to existing facilities should be considered on the merits of the specific case. The resultant design criteria shall meet the requirements also contained in Appendix 6301, "Facilities General Design Criteria."

1. Facility Considerations

a. Design

(1) Exposure rates in work areas should be reduced as low as practicable by proper facility design and equipment layout. Design factors to consider are: occupancy time, source term, spacing, processes, equipment, and shielding. Onsite personnel exposure levels less than one-fifth of the permissible dose equivalent limits prescribed in ERDAM 0524 should be used as a design objective.

(2) Primary means for assuring protection should be through physical safeguards, e.g., remote handling, equipment, shielding, etc. Administrative controls should be regarded as a secondary means.

(3) The general concept in the design of a facility for purposes of high level contamination confinement should be primary, secondary and tertiary confinement. Primary confinement would be the process enclosures and their ventilation and air cleaning systems, secondary confinement would be the operating area compartments and their ventilation and air cleaning systems, and the tertiary confinement would be the structure and its ventilation and air cleaning systems.

(4) Compartmentalization should be provided to isolate high risk areas.

(5) Decommissioning requirements should be considered in the design of a facility. The avoidance of rough surfaces, cracks, and crevices in potential contamination areas should be considered in this context.

(6) The use of protective coating in radiation areas should comply with the specifications contained in ANSI N5.9 1967 (Protective Coating for the Nuclear Industry).

(7) Interior surfaces, as well as layout of ducts and pipes, should be designed to minimize buildup of contamination and exposure to personnel, and to facilitate cleanup.

(8) Equipment and components requiring frequent servicing should be located in areas free of radiation or in the lowest practicable radiation field.

(9) Ventilation systems should be designed to assure control of air contaminants. Redundant equipment should be provided in all exhaust systems servicing contaminated and potentially contaminated areas. The system should permit easy safe access for servicing.

(10) Air cleaning systems should be designed to reduce plant releases and minimize vulnerability to adverse conditions such as fire or explosion. The design should also permit in-place testing of both online and standby filter installations. These tests should be performed as recommended in ANSI N101.1 1972 (Efficiency Testing of Air Cleaning

Systems Containing Devices for Removal of Particles).

(11) Liquid waste systems should be designed to confine or reduce releases to environmental media offsite and onsite.

(12) Personnel and equipment traffic patterns should be well defined so as to minimize the potential spread of contamination. Avenues of ingress and egress should be designed, posted, and/or otherwise controlled to minimize transient or casual exposure.

b. Operating Equipment

(1) All operating equipment including enclosures, glove boxes, conveyors, hoods, ventilation and air cleaning systems should be routinely inspected to assure optimum performance from the safety viewpoint.

(2) For those facilities involving glove box operations, the following guidance applies:

(a) Double ring ports should be required for all glove box gloves.

(b) Equipment located in glove boxes should be designed for in-place maintenance.

(c) The inner surface of a glove box should be designed to permit easy, efficient decontamination. Since contamination buildup in a glove box is a large contributor to worker exposure, a routine schedule for inspection and decontamination of glove boxes should be established.

(d) Air cleaning should be provided at the glove box exhaust port.

(3) Valve packing and gaskets should be selected on the basis of achieving optimum performance in order to minimize leakage and spillage of radioactive materials.

c. Monitoring and Protective Equipment

(1) Ambient air and exhaust monitoring systems including readout and preset alarms should be located to permit rapid monitoring of airborne releases. Monitors should be selected, tested, and calibrated in accordance with the general guidance contained in ANSI N13.1 (Guide to Sampling Airborne Radioactive Materials in a Nuclear Facility).

(2) Portable instrumentation should be available as appropriate. Scheduled tests and calibration should comply with the specifications contained in ANSI N13/42 WG4–(Radiation Protection Instrumentation Test and Calibration–Final Draft 1974).

(3) Inhalation and ingestion should be minimized by proper use of state-of-the-art respiratory protection. The respirator program shall comply with guidance contained in ANSI Z88.2 (Respiratory Protection).

(4) To achieve optimum accuracy, personnel dosimeters should comply with the performance parameters contained in ANSI N13.5 (Performance Specifications for Direct Reading and Indirect Reading Pocket Dosimeters for x and Gamma Radiation), ANSI N13.7 (Film Badge Performance) and ANSI N13/42 WG 1 Final draft 1974–(TLD A Standard for Performance).

(5) Radiation monitoring systems (e.g., area monitors, effluent monitors, etc.) should be appropriately selected, installed, tested, and calibrated following the recommendations contained in ANSI N13/42 WG 7 (Specification and Performance of Onsite Instrumentation for Continuously Monitoring Radioactivity in Effluents).

(6) Protection systems should have reliability and in situ testability. The design of critical systems such as alarm systems shall provide for redundancy and independence to assure (a) that no single failure results in the loss of the protection function, and (b) that removal from service of any component does not result in loss of the redundancy.

(7) The emergency warning systems should be designed to comply with the performance specifications contained in ANSI N16.2 (Criticality Accident Alarm) and ANSI N2.3 (Immediate Evacuation Signal for Use in Industrial Facilities Where Radiation Exposure May Occur).

d. Procedures

(1) Records of exposure data, contamination surveys, airborne and internal exposure data should be properly evaluated from the viewpoint of determining whether exposures are being maintained as low as practicable. Where appropriate, procedures should be substituted to maintain exposures to as low as practicable.

(2) Total man-rems should be estimated for large tasks and a total man-rem dose established prior to initiating the job.

(3) Approximate radiation levels should be posted in work areas.

(4) Contamination control procedures should be established for all jobs where contamination may be present. Supervision should assure that workers follow proper procedures in order to maintain their exposures as low as practicable.

(5) Special tools and temporary shielding should be used where practicable to reduce radiation exposures.

(6) Tasks should be completed with the fewest people in the radiation field consistent with safe operations. Procedures should be established to assure there is effective use of personnel and personnel are not idle in the radiation area.

(7) Where appropriate, time and motion studies should be conducted to assure that workers in radiation fields complete assigned tasks within a minimum time span consistent with safe operations.

(8) Within the bounds of economic practicability, objectives should include reducing exposure rates in worker locations rather than institute a system of worker rotation to minimize exposure to individuals. Emphasis should be placed on worker efficiency.

(9) Worker locations should be properly evaluated on a routine basis to determine whether sufficient effort has been expended to assure that exposures are maintained ALAP. In the case of glove box operations, this would include a determination that box contamination buildup is minimized, shielding is optimum, and workers complete their tasks within a reasonable time frame.

(10) Buffer area control points should be clearly established and contain appropriate equipment and clothing to permit proper contamination control. Maintaining proper supervision in the area is essential to maintaining exposure as low as practicable.

(11) Procedures should be instituted to periodically review the potential for and actual release of radioactivity to the environment in gaseous and liquid effluents.

2. Radiation Safety Management

a. Training

(1) Worker safety training programs should be established and conducted at a sufficient frequency as to familiarize the worker of the fundamentals of health physics and the proper procedures for maintaining exposures and plant releases to as low as practicable. Training programs should be kept up to date to reflect plant modifications and procedures. The program should be on a continuing basis to enable training of replacement personnel as well as retraining to assure that personnel remain proficient. A radiation safety training program should include but not be limited to:

(a) Principles of design operation and maintenance of the plant, project equipment or experiment.

(b) Potential problem areas from the radiological viewpoint.

(c) Basic characteristics of radiation and contamination.

(d) Methods (procedures—equipment) for exposure and contamination control.

(e) Basic understanding of biological dose, and methods of assessment.

(f) Emergency procedures and systems.

(2) Operations supervision should have a good understanding of the radiological characteristics and potential safety problem areas associated with their program including all the training elements covered under (1) above. This would permit a proper assessment of the adequacy of controls instituted to maintain exposures to as low as practicable.

ANNEX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See notes at end of annex)

Element (atomic number)	Isotope,* soluble (S); insoluble (I)			Table I Controlled Area: Column 1 Air ($\mu c/ml$)	Table I Controlled Area: Column 2 Water ($\mu c/ml$)	Table II Uncontrolled Area†: Column 1 Air ($\mu c/ml$)	Table II Uncontrolled Area†: Column 2 Water ($\mu c/ml$)
Actinium (89)	Ac	227	S	2×10^{-12}	6×10^{-4}	8×10^{-14}	2×10^{-6}
			I	3×10^{-11}	9×10^{-3}	9×10^{-13}	3×10^{-4}
	Ac	228	S	8×10^{-8}	3×10^{-3}	3×10^{-9}	9×10^{-5}
			I	2×10^{-8}	3×10^{-3}	6×10^{-10}	9×10^{-5}
Americium (95)	Am	241	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
			I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Am	242m	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
			I	3×10^{-10}	3×10^{-3}	9×10^{-12}	9×10^{-5}
	Am	242	S	4×10^{-8}	4×10^{-3}	1×10^{-9}	1×10^{-4}
			I	5×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Am	243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
			I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Am	244	S	4×10^{-6}	1×10^{-1}	1×10^{-7}	5×10^{-3}
			I	2×10^{-5}	1×10^{-1}	8×10^{-7}	5×10^{-3}
Antimony (51)	Sb	122	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
			I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
	Sb	124	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
			I	2×10^{-8}	7×10^{-4}	7×10^{-10}	2×10^{-5}
	Sb	125	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	3×10^{-8}	3×10^{-3}	9×10^{-10}	1×10^{-4}
Argon (18)	A	37	Sub	3×10^{-3}	—	1×10^{-4}	
	A	41	Sub	2×10^{-6}		4×10^{-5}	
Arsenic (33)	As	73	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	5×10^{-4}
			I	4×10^{-7}	1×10^{-2}	1×10^{-8}	1×10^{-4}
	As	74	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
			I	1×10^{-7}	2×10^{-3}	4×10^{-9}	5×10^{-5}
	As	76	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
			I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	As	77	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
			I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Astatine (85)	At	211	S	4×10^{-9}	2×10^{-5}	2×10^{-10}	2×10^{-6}
			I	3×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
Barium (56)	Ba	131	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
			I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ba	140	S	1×10^{-7}	8×10^{-4}	4×10^{-9}	3×10^{-5}
			I	4×10^{-8}	7×10^{-4}	1×10^{-9}	2×10^{-5}

*"Sub" means that values given are for submersion in a semispherical infinite cloud of airborne material.

†These values apply to individuals in uncontrolled areas. One-third of these values will be used for a suitable sample of the population.

NOTE: $\mu Ci/ml \times 10^{12} = pCi/m^3$; $\mu Ci/ml \times 10^{3} = Ci/L$

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of annex)

Element (atomic number)	Isotope, soluble (S): insoluble (I)		Table I Controlled Area		Table II Uncontrolled Area	
			Column 1 Air (μc/ml)	Column 2 Water (μc/ml)	Column 1 Air (μc/ml)	Column 2 Water (μc/ml)
Berkelium (97)	Bk 249	S	9×10^{-10}	2×10^{-2}	3×10^{-11}	6×10^{-4}
		I	1×10^{-7}	2×10^{-2}	4×10^{-9}	6×10^{-4}
	Bk 250	S	1×10^{-7}	6×10^{-3}	5×10^{-9}	2×10^{-4}
		I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Beryllium (4)	Be 7	S	6×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
		I	1×10^{-6}	5×10^{-2}	4×10^{-8}	2×10^{-3}
Bismuth (83)	Bi 206	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
		I	1×10^{-7}	1×10^{-3}	5×10^{-9}	4×10^{-5}
	Bi 207	S	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
		I	1×10^{-8}	2×10^{-3}	5×10^{-10}	6×10^{-5}
	Bi 210	S	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
		I	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Bi 212	S	1×10^{-7}	1×10^{-2}	3×10^{-9}	4×10^{-4}
		I	2×10^{-7}	1×10^{-2}	7×10^{-9}	4×10^{-4}
Bromine (35)	Br 82	S	1×10^{-6}	8×10^{-3}	4×10^{-8}	3×10^{-4}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Cadmium (48)	Cd 109	S	5×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
		I	7×10^{-8}	5×10^{-3}	3×10^{-9}	2×10^{-4}
	Cd 115m	S	4×10^{-8}	7×10^{-4}	1×10^{-9}	3×10^{-5}
		I	4×10^{-5}	7×10^{-4}	1×10^{-9}	3×10^{-5}
	Cd 115	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Calcium (20)	Ca 45	S	3×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Ca 47	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
Californium (98)	Cf 249	S	2×10^{-12}	1×10^{-4}	5×10^{-14}	4×10^{-6}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cf 250	S	5×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf 251	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf 252	S	6×10^{-12}	2×10^{-4}	2×10^{-13}	7×10^{-5}
		I	3×10^{-11}	2×10^{-4}	1×10^{-12}	7×10^{-5}
	Cf 253	S	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
		I	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
	Cf 254	S	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
		I	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
Carbon (6)	C 14	S	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	(CO_2)	Sub	5×10^{-5}		1×10^{-6}	
Cerium (58)	Ce 141	S	4×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	3×10^{-3}	5×10^{-9}	9×10^{-5}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of annex)

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Cerium (58) Cont'd.	Ce	143	S	3×10^{-7}	1×10^{-3}	9×10^{-9}	4×10^{-5}
			I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	Ce	144	S	1×10^{-8}	3×10^{-4}	3×10^{-10}	1×10^{-5}
			I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Cesium (55)	Cs	131	S	1×10^{-5}	7×10^{-2}	4×10^{-7}	2×10^{-3}
			I	3×10^{-6}	3×10^{-2}	1×10^{-7}	9×10^{-4}
	Cs	134m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
			I	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
	Cs	134	S	4×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
			I	1×10^{-8}	1×10^{-3}	4×10^{-10}	4×10^{-5}
	Cs	135	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	9×10^{-8}	7×10^{-3}	3×10^{-9}	2×10^{-4}
	Cs	136	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
			I	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
	Cs	137	S	6×10^{-8}	4×10^{-4}	2×10^{-9}	2×10^{-5}
			I	1×10^{-8}	1×10^{-3}	5×10^{-10}	4×10^{-5}
Chlorine (17)	Cl	36	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
			I	2×10^{-8}	2×10^{-3}	8×10^{-10}	6×10^{-5}
	Cl	38	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
			I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
Chromium (24)	Cr	51	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
			I	2×10^{-6}	5×10^{-2}	8×10^{-8}	2×10^{-3}
Cobalt (27)	Co	57	S	3×10^{-6}	2×10^{-2}	1×10^{-7}	5×10^{-4}
			I	2×10^{-7}	1×10^{-2}	6×10^{-9}	4×10^{-4}
	Co	58m	S	2×10^{-5}	8×10^{-2}	6×10^{-7}	3×10^{-3}
			I	9×10^{-6}	6×10^{-2}	3×10^{-7}	2×10^{-3}
	Co	58	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	5×10^{-8}	3×10^{-3}	2×10^{-9}	9×10^{-5}
	Co	60	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
			I	9×10^{-9}	1×10^{-3}	3×10^{-10}	3×10^{-5}
Copper (29)	Cu	64	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
			I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Curium (96)	Cm	242	S	1×10^{-10}	7×10^{-4}	4×10^{-12}	2×10^{-5}
			I	2×10^{-10}	7×10^{-4}	6×10^{-12}	2×10^{-5}
	Cm	243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	5×10^{-6}
			I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cm	244a	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
			I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cm	245	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
			I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Cm	246	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
			I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}

Approved: March 30, 1977

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of annex)

Element (atomic number)	Isotope, soluble (S): insoluble (I)		Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Curium (96) Cont'd.	Cm 247	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	6×10^{-4}	4×10^{-12}	2×10^{-5}
	Cm 248	S	6×10^{-13}	1×10^{-5}	2×10^{-14}	4×10^{-7}
		I	1×10^{-11}	4×10^{-5}	4×10^{-13}	1×10^{-6}
	Cm 249	S	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}
		I	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}
Dysprosium (66)	Dy 165	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
	Dy 166	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Einsteinium (99)	Es 253	S	8×10^{-10}	7×10^{-4}	3×10^{-11}	2×10^{-5}
		I	6×10^{-10}	7×10^{-4}	2×10^{-11}	2×10^{-5}
	Es 254m	S	5×10^{-9}	8×10^{-4}	2×10^{-10}	2×10^{-5}
		I	6×10^{-9}	5×10^{-4}	2×10^{-10}	2×10^{-5}
	Es 254	S	2×10^{-11}	4×10^{-4}	6×10^{-13}	1×10^{-5}
		I	1×10^{-10}	4×10^{-4}	4×10^{-12}	1×10^{-5}
	Es 255	S	5×10^{-10}	5×10^{-4}	2×10^{-11}	3×10^{-5}
		I	4×10^{-10}	8×10^{-4}	1×10^{-11}	3×10^{-4}
Erbium (68)	Er 169	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	4×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	Er 171	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Europium (63)	Eu 152	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	(T/2=9.2 hrs)	I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Eu 152	S	1×10^{-8}	2×10^{-3}	4×10^{-10}	8×10^{-5}
	(T/2=13 yrs)	I	2×10^{-8}	2×10^{-3}	6×10^{-10}	8×10^{-5}
	Eu 154	S	4×10^{-9}	6×10^{-4}	1×10^{-10}	2×10^{-5}
		I	7×10^{-9}	6×10^{-4}	2×10^{-10}	2×10^{-5}
	Eu 155	S	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
		I	7×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
Fermium (100)	Fm 254	S	6×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
		I	7×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Fm 255	S	2×10^{-8}	1×10^{-3}	6×10^{-10}	3×10^{-5}
		I	1×10^{-8}	1×10^{-3}	4×10^{-10}	3×10^{-5}
	Fm 256	S	3×10^{-9}	3×10^{-5}	1×10^{-10}	9×10^{-7}
		I	2×10^{-9}	3×10^{-5}	6×10^{-11}	9×10^{-7}
Fluorine (9)	F 18	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
		I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
Gadolinium (64)	Gd 153	S	2×10^{-7}	6×10^{-3}	8×10^{-9}	2×10^{-4}
		I	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Gd 159	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of annex)

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Gallium (31)	Ga	72	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
			I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Germanium (32)	Ge	71	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
			I	6×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
Gold (79)	Au	196	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
			I	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
	Au	198	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
			I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Au	199	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
			I	8×10^{-7}	4×10^{-3}	3×10^{-8}	2×10^{-4}
Hafnium (72)	Hf	181	S	4×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
			I	7×10^{-8}	2×10^{-3}	3×10^{-9}	7×10^{-5}
Holmium (67)	Ho	166	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
			I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Hydrogen (1)	H	3	S	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
			I	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
			Sub	2×10^{-3}		4×10^{-5}	
Indium (49)	In	113m	S	8×10^{-6}	4×10^{-2}	3×10^{-7}	1×10^{-3}
			I	7×10^{-6}	4×10^{-2}	2×10^{-7}	1×10^{-3}
	In	114m	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
			I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
	In	115m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
			I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	In	115	S	2×10^{-7}	3×10^{-3}	9×10^{-9}	9×10^{-5}
			I	3×10^{-8}	3×10^{-3}	1×10^{-9}	9×10^{-5}
Iodine (53)*	I	125	S	3×10^{-9}	2×10^{-5}	8×10^{-11}	2×10^{-7}
			I	2×10^{-7}	6×10^{-3}	6×10^{-9}	2×10^{-4}
	I	126	S	4×10^{-9}	3×10^{-5}	9×10^{-11}	3×10^{-7}
			I	3×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	I	129	S	8×10^{-10}	5×10^{-5}	2×10^{-11}	6×10^{-8}
			I	7×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
	I	131	S	4×10^{-9}	3×10^{-5}	1×10^{-10}	3×10^{-7}
			I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	I	132	S	1×10^{-7}	8×10^{-4}	3×10^{-9}	8×10^{-4}
			I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	I	133	S	2×10^{-8}	1×10^{-4}	4×10^{-10}	1×10^{-6}
			I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}

*In the derivation of the concentration guides for soluble forms of iodine in Table II, a 2 gram thyroid (infants) and daily intakes of 3×10^{6} ml of air and 1×10^{3} ml of water (fluid water plus water contents of foods) assumed.

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of annex)

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Iodine (53) Cont'd.	I	134	S	3×10^{-7}	2×10^{-3}	6×10^{-9}	2×10^{-5}
			I	3×10^{-6}	2×10^{-2}	1×10^{-7}	6×10^{-4}
	I	135	S	5×10^{-7}	4×10^{-4}	1×10^{-9}	4×10^{-6}
			I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Iridium (77)	Ir	190	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
			I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ir	192	S	1×10^{-7}	1×10^{-3}	4×10^{-9}	4×10^{-5}
			I	3×10^{-8}	1×10^{-3}	9×10^{-10}	4×10^{-5}
	Ir	194	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
			I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
Iron (26)	Fe	55	S	9×10^{-7}	2×10^{-2}	3×10^{-8}	8×10^{-4}
			I	1×10^{-6}	7×10^{-2}	3×10^{-8}	2×10^{-3}
	Fe	59	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
			I	5×10^{-8}	2×10^{-3}	2×10^{-9}	5×10^{-5}
Krypton (36)	Kr	85m	Sub	6×10^{-6}		1×10^{-7}	
	Kr	85	Sub	1×10^{-5}		3×10^{-7}	
	Kr	87	Sub	1×10^{-6}		2×10^{-8}	
	Kr	88	Sub	1×10^{-6}		2×10^{-8}	
Lanthanum (57)	La	140	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
			I	1×10^{-7}	7×10^{-4}	4×10^{-9}	2×10^{-5}
Lead (82)	Pb	203	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
			I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	Pb	210	S	1×10^{-10}	4×10^{-6}	4×10^{-12}	1×10^{-7}
			I	2×10^{-10}	5×10^{-3}	8×10^{-12}	2×10^{-4}
	Pb	212	S	2×10^{-8}	6×10^{-4}	6×10^{-10}	2×10^{-5}
			I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
Lutetium (71)	Lu	177	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Manganese (25)	Mn	52	S	2×10^{-7}	1×10^{-3}	7×10^{-9}	3×10^{-5}
			I	1×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Mn	54	S	4×10^{-7}	4×10^{-3}	1×10^{-8}	1×10^{-4}
			I	4×10^{-8}	3×10^{-3}	1×10^{-9}	1×10^{-4}
	Mn	56	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Mercury (80)	Hg	197m	S	7×10^{-7}	6×10^{-3}	3×10^{-8}	2×10^{-4}
			I	8×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Hg	197	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
			I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
	Hg	203	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
			I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
Molybdenum (42)	Mo	99	S	7×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
			I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of annex)

Element (atomic number)	Isotope, soluble (S); insoluble (I)		Table I Controlled Area		Table II Uncontrolled Area	
			Column 1 Air (μc/ml)	Column 2 Water (μc/ml)	Column 1 Air (μc/ml)	Column 2 Water (μc/ml)
Neodymium (60)	Nd 144	S	8×10^{-11}	2×10^{-3}	3×10^{-12}	7×10^{-5}
		I	3×10^{-10}	2×10^{-3}	1×10^{-11}	8×10^{-5}
	Nd 147	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	2×10^{-3}	8×10^{-9}	6×10^{-5}
	Nd 149	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	1×10^{-6}	8×10^{-3}	5×10^{-8}	3×10^{-4}
Neptunium (93)	Np 237	S	4×10^{-12}	9×10^{-5}	1×10^{-13}	3×10^{-6}
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	Np 239	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	7×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
Nickel (28)	Ni 59	S	5×10^{-7}	6×10^{-3}	2×10^{-8}	2×10^{-4}
		I	8×10^{-7}	6×10^{-2}	3×10^{-8}	2×10^{-3}
	Ni 63	S	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	7×10^{-4}
	Ni 65	S	9×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Niobium (Columbium) (41)	Nb 93m	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	4×10^{-4}
		I	2×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Nb 95	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	1×10^{-7}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Nb 97	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
Osmium (76)	Os 185	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	7×10^{-5}
	Os 191m	S	2×10^{-5}	7×10^{-2}	6×10^{-7}	3×10^{-3}
		I	9×10^{-6}	7×10^{-2}	3×10^{-7}	2×10^{-3}
	Os 191	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Os 193	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	9×10^{-9}	5×10^{-5}
Palladium (46)	Pd 103	S	1×10^{-6}	1×10^{-2}	5×10^{-8}	3×10^{-4}
		I	7×10^{-7}	8×10^{-3}	3×10^{-8}	3×10^{-4}
	Pd 109	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Phosphorus (15)	P 32	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	8×10^{-8}	7×10^{-4}	3×10^{-9}	2×10^{-5}
Platinum (78)	Pt 191	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Pt 193	S	1×10^{-6}	3×10^{-2}	9×10^{-3}	9×10^{-4}
		I	3×10^{-7}	5×10^{-2}	1×10^{-3}	2×10^{-3}
	Pt 193m	S	7×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of annex)

Element (atomic number)	Isotope. soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Platinum (78) Cont'd.	Pt	197m	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
			I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
	Pt	197	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Plutonium (94)	Pu	238	S	2×10^{-12}	1×10^{-4}	7×10^{-14}	5×10^{-6}
			I	3×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu	239	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
			I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu	240	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
			I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu	241	S	9×10^{-11}	7×10^{-3}	3×10^{-12}	2×10^{-4}
			I	4×10^{-8}	4×10^{-2}	1×10^{-9}	1×10^{-3}
	Pu	242	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
			I	4×10^{-11}	9×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu	243	S	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
			I	2×10^{-6}	1×10^{-2}	8×10^{-8}	3×10^{-4}
	Pu	244	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
			I	3×10^{-11}	3×10^{-4}	1×10^{-12}	1×10^{-5}
Polonium (84)	Po	210	S	5×10^{-10}	2×10^{-5}	2×10^{-11}	7×10^{-7}
			I	2×10^{-10}	8×10^{-4}	7×10^{-12}	3×10^{-5}
Potassium (19)	K	42	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
			I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Praseodymium (59)	Pr	142	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
			I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Pr	143	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
			I	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
Promethium (61)	Pm	147	S	6×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
			I	[illegible]	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Pm	149	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
			I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Protactinium (91)	Pa	230	S	2×10^{-9}	7×10^{-3}	6×10^{-11}	2×10^{-4}
			I	8×10^{-10}	7×10^{-3}	3×10^{-11}	2×10^{-4}
	Pa	231	S	1×10^{-12}	3×10^{-5}	4×10^{-14}	9×10^{-7}
			I	1×10^{-10}	8×10^{-4}	4×10^{-12}	2×10^{-5}
	Pa	233	S	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
			I	2×10^{-7}	3×10^{-3}	6×10^{-9}	1×10^{-4}
Radium (88)	Ra	223	S	2×10^{-9}	2×10^{-5}	6×10^{-11}	7×10^{-7}
			I	2×10^{-10}	1×10^{-4}	8×10^{-12}	4×10^{-6}
	Ra	224	S	5×10^{-9}	7×10^{-5}	2×10^{-10}	2×10^{-6}
			I	7×10^{-10}	2×10^{-4}	2×10^{-11}	5×10^{-6}
	Ra	226	S	3×10^{-11}	4×10^{-7}	3×10^{-12}	3×10^{-8}
			I	5×10^{-11}	9×10^{-4}	2×10^{-12}	3×10^{-5}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of annex)

Element (atomic number)	Isotope. soluble (S): insoluble (I)		Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Radium (88) Cont'd.	Ra 228	S	7×10^{-11}	8×10^{-7}	2×10^{-12}	3×10^{-8}
		I	4×10^{-11}	7×10^{-4}	1×10^{-12}	3×10^{-5}
Radon (86)	Rn 220	S	3×10^{-7}		1×10^{-8}	
	Rn 222	S	1×10^{-7}		3×10^{-9}	
Rhenium (75)	Re 183	S	3×10^{-6}	2×10^{-2}	9×10^{-8}	6×10^{-4}
		I	2×10^{-7}	8×10^{-3}	5×10^{-9}	3×10^{-4}
	Re 186	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Re 187	S	4×10^{-6}	4×10^{-2}	3×10^{-7}	3×10^{-3}
		I	5×10^{-7}	4×10^{-2}	2×10^{-8}	2×10^{-3}
	Re 188	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Rhodium (45)	Rh 103m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
		I	6×10^{-5}	3×10^{-1}	2×10^{-6}	1×10^{-2}
	Rh 105	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Rubidium (37)	Rb 86	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	7×10^{-8}	7×10^{-4}	2×10^{-9}	2×10^{-5}
	Rb 87	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	7×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Ruthenium (44)	Ru 97	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
	Ru 103	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	8×10^{-8}	2×10^{-3}	3×10^{-9}	8×10^{-5}
	Ru 105	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Ru 106	S	8×10^{-8}	4×10^{-4}	3×10^{-9}	1×10^{-5}
		I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Samarium (62)	Sm 147	S	7×10^{-11}	2×10^{-3}	2×10^{-12}	6×10^{-5}
		I	3×10^{-10}	2×10^{-3}	9×10^{-12}	7×10^{-5}
	Sm 151	S	6×10^{-8}	1×10^{-2}	2×10^{-9}	4×10^{-4}
		I	1×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Sm 153	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Scandium (21)	Sc 46	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-8}	1×10^{-3}	8×10^{-10}	4×10^{-5}
	Sc 47	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
	Sc 48	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Selenium (34)	Se 75	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	1×10^{-7}	8×10^{-3}	4×10^{-9}	3×10^{-4}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of annex)

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area		Table II Uncontrolled Area	
				Column 1 Air ($\mu c/ml$)	Column 2 Water ($\mu c/ml$)	Column 1 Air ($\mu c/ml$)	Column 2 Water ($\mu c/ml$)
Silicon (14)	Si	31	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
			I	1×10^{-6}	6×10^{-3}	3×10^{-8}	2×10^{-4}
Silver (47)	Ag	105	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	8×10^{-8}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Ag	110m	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
			I	1×10^{-8}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Ag	111	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
			I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Sodium (11)	Na	22	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
			I	9×10^{-9}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Na	24	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
			I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Strontium (38)	Sr	85m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
			I	3×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
	Sr	85	S	2×10^{-7}	3×10^{-3}	8×10^{-9}	1×10^{-4}
			I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Sr	89	S	3×10^{-8}	3×10^{-4}	3×10^{-10}	3×10^{-6}
			I	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Sr	90	S	1×10^{-9}	1×10^{-5}	3×10^{-11}	3×10^{-7}
			I	5×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Sr	91	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
			I	3×10^{-7}	1×10^{-3}	9×10^{-9}	5×10^{-5}
	Sr	92	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
			I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Sulfur (16)	S	35	S	3×10^{-7}	2×10^{-3}	9×10^{-9}	6×10^{-5}
			I	3×10^{-7}	8×10^{-3}	9×10^{-9}	3×10^{-4}
Tantalum (73)	Ta	182	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
			I	2×10^{-8}	1×10^{-3}	7×10^{-10}	4×10^{-5}
Technetium (43)	Tc	96m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
			I	3×10^{-5}	3×10^{-1}	1×10^{-6}	1×10^{-2}
	Tc	96	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Tc	97m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
			I	2×10^{-7}	5×10^{-3}	5×10^{-9}	2×10^{-4}
	Tc	97	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
			I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Tc	99m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
			I	1×10^{-5}	8×10^{-2}	5×10^{-7}	3×10^{-3}
	Tc	99	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
			I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Tellurium (52)	Te	125m	S	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
			I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of annex)

Element (atomic number)	Isotope, soluble (S): insoluble (I)			Table I Controlled Area		Table II Uncontrolled Area	
				Column 1 Air (μc/ml)	Column 2 Water (μc/ml)	Column 1 Air (μc/ml)	Column 2 Water (μc/ml)
Tellurium (52) Cont'd.	Te	127m	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
			I	4×10^{-8}	2×10^{-3}	1×10^{-9}	5×10^{-5}
	Te	127	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
			I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Te	129m	S	8×10^{-8}	1×10^{-3}	3×10^{-9}	3×10^{-5}
			I	3×10^{-8}	6×10^{-4}	1×10^{-9}	2×10^{-5}
	Te	129	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
			I	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	Te	131m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
			I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
	Te	132	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
			I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Terbium (65)	Tb	160	S	1×10^{-7}	1×10^{-3}	3×10^{-9}	4×10^{-5}
			I	3×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
Thallium (81)	Tl	200	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
			I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
	Tl	201	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
			I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Tl	202	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	2×10^{-7}	2×10^{-3}	8×10^{-9}	7×10^{-5}
	Tl	204	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	3×10^{-8}	2×10^{-3}	9×10^{-10}	6×10^{-5}
Thorium (90)	Th	227	S	3×10^{-10}	5×10^{-4}	1×10^{-11}	2×10^{-5}
			I	2×10^{-10}	5×10^{-4}	6×10^{-12}	2×10^{-5}
	Th	228	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
			I	6×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
	Th	230	S	2×10^{-12}	5×10^{-5}	8×10^{-14}	2×10^{-6}
			I	1×10^{-11}	9×10^{-4}	3×10^{-13}	3×10^{-5}
	Th	231	S	1×10^{-6}	7×10^{-3}	5×10^{-8}	2×10^{-4}
			I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
	Th	232	S	3×10^{-11}	5×10^{-5}	1×10^{-12}	2×10^{-6}
			I	3×10^{-11}	1×10^{-3}	1×10^{-12}	4×10^{-5}
	Th-natural*		S	3×10^{-11}	3×10^{-5}	1×10^{-12}	1×10^{-6}
			I	3×10^{-11}	3×10^{-4}	1×10^{-12}	1×10^{-5}
	Th	234	S	6×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
			I	3×10^{-8}	5×10^{-4}	1×10^{-9}	2×10^{-5}
Thulium (69)	Tm	170	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
			I	3×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}

*A curie of natural thorium means the sum of 3.7×10^{10} dis/sec from Th 232 plus 3.7×10^{10} dis/sec from Th 228. One curie of natural thorium is equivalent to 9,000 kilograms or 19,850 pounds of natural thorium.

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of annex)

Element (atomic number)	Isotope, soluble (S): insoluble (I)			Table I Controlled Area Column 1 Air ($\mu c/ml$)	Table I Controlled Area Column 2 Water ($\mu c/ml$)	Table II Uncontrolled Area Column 1 Air ($\mu c/ml$)	Table II Uncontrolled Area Column 2 Water ($\mu c/ml$)
Thulium (69) Cont'd.	Tm	171	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	5×10^{-4}
			I	2×10^{-7}	1×10^{-2}	8×10^{-9}	5×10^{-4}
Tin (50)	Sn	113	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
			I	5×10^{-8}	2×10^{-3}	2×10^{-9}	8×10^{-5}
	Sn	125	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
			I	8×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Tungsten (Wolfram) (74)	W	181	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
			I	1×10^{-7}	1×10^{-2}	4×10^{-9}	3×10^{-4}
	W	185	S	8×10^{-7}	1×10^{-3}	3×10^{-8}	1×10^{-4}
			I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-5}
	W	187	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-3}
			I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Uranium (92)	U	230	S	3×10^{-10}	1×10^{-4}	1×10^{-11}	5×10^{-6}
			I	1×10^{-10}	1×10^{-4}	4×10^{-12}	5×10^{-6}
	U	232	S	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
			I	3×10^{-11}	8×10^{-4}	9×10^{-13}	3×10^{-5}
	U	233	S	5×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
			I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	U	234	S	6×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
			I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	U	235	S	5×10^{-10}	8×10^{-4}	2×10^{-11}	3×10^{-5}
			I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	U	236	S	6×10^{-10}	1×10^{-3}	2×10^{-11}	3×10^{-5}
			I	1×10^{-10}	1×10^{-3}	4×10^{-12}	3×10^{-5}
	U	238	S	7×10^{-11}	1×10^{-3}	3×10^{-12}	4×10^{-5}
			I	1×10^{-10}	1×10^{-3}	5×10^{-12}	4×10^{-5}
	U	240	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
			I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
	U-natural*		S	7×10^{-11}	5×10^{-4}	3×10^{-12}	2×10^{-5}
			I	6×10^{-11}	5×10^{-4}	2×10^{-12}	2×10^{-5}
Vanadium (23)	V	48	S	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
			I	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
Xenon (54)	Xe	131m	Sub	2×10^{-5}		4×10^{-7}	
	Xe	133	Sub	1×10^{-5}		3×10^{-7}	
	Xe	133m	Sub	1×10^{-5}		3×10^{-7}	
	Xe	135	Sub	4×10^{-6}		1×10^{-7}	
Ytterbium (70)	Yb	175	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}

*A curie of natural uranium means the sum of 3.7×10^{10} disintegrations per second from U 238 plus 3.7×10^{10} dis/sec from U 234 plus 1.7×10^{9} dis/sec from U 235. One curie of natural uranium is equivalent to 3,000 kilograms or 6,615 pounds of natural uranium.

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of annex)

Element (atomic number)	Isotope.	soluble (S): insoluble (I)	Table I Controlled Area Column 1 Air (μc/ml)	Table I Controlled Area Column 2 Water (μc/ml)	Table II Uncontrolled Area Column 1 Air (μc/ml)	Table II Uncontrolled Area Column 2 Water (μc/ml)
Yttrium (39)	Y 90	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
		I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	Y 91m	S	2×10^{-5}	1×10^{-1}	8×10^{-7}	3×10^{-3}
		I	2×10^{-5}	1×10^{-1}	6×10^{-7}	3×10^{-3}
	Y 91	S	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
		I	3×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Y 92	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Y 93	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Zinc (30)	Zn 65	S	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
		I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
	Zn 69m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Zn 69	S	7×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
		I	9×10^{-6}	5×10^{-2}	3×10^{-7}	2×10^{-3}
Zirconium (40)	Zr 93	S	1×10^{-7}	2×10^{-2}	4×10^{-9}	8×10^{-4}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Zr 95	S	1×10^{-7}	2×10^{-3}	4×10^{-9}	6×10^{-5}
		I	3×10^{-8}	2×10^{-3}	1×10^{-9}	6×10^{-5}
	Zr 97	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	9×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours.		Sub	1×10^{-6}		3×10^{-8}	
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours.			3×10^{-9}	9×10^{-5}	1×10^{-10}	3×10^{-6}
Any single radionuclide not listed above which decays by alpha emission or spontaneous fission.			6×10^{-13}	4×10^{-7}	2×10^{-14}	3×10^{-8}

NOTE: In any case where there is a mixture in air or water of more than one radionuclide, the guide values, for purposes of this annex, should be determined as follows:

1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values should be derived as follows: Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the guide otherwise established in this annex for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture will not exceed "1" (i.e., "unity").

EXAMPLE: If radionuclides A, B, and C are present in concentrations C_A, C_B, and C_C, and if the applicable CGs are CG_A, CG_B, and CG_C, respectively, then the concentrations should be limited so that the following relationship exists:

$$\frac{C_A}{CG_A} + \frac{C_B}{CG_B} + \frac{C_C}{CG_C} \leq 1$$

2. If either the identity or the concentration of any radionuclide in the mixture is not known, the guide values for purposes of this annex will be:

a. For purposes of Table I, Col. 1, 6×10^{-13}
b. For purposes of Table I, Col. 2, 4×10^{-7}
c. For purposes of Table II, Col. 1, 2×10^{-14}
d. For purposes of Table II, Col. 2, 3×10^{-8}

3. If any of the conditions specified below are met, the corresponding values specified below may be used in lieu of those specified in 2., above.

a. If the identity of each radionuclide in the mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the concentration guide for the mixture is the guide specified in this annex for the radionuclide in the mixture having the lowest concentration guide, or

b. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in this annex are not present in the mixture, the concentration guide for the mixture is the lowest concentration guide specified in this annex for any radionuclide which is not known to be absent from the mixture, or

c.

Element (atomic number) and isotope	Table I Controlled Area: Column 1 Air (µc/ml)	Table I Controlled Area: Column 2 Water (µc/ml)	Table II Uncontrolled Area: Column 1 Air (µc/ml)	Table II Uncontrolled Area: Column 2 Water (µc/ml)
If it is known that Sr 90, I 125, I 126, I 129, I 131 (I 133, Table II only) Pb 210, Po 210, At 211, Ra 223, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231, Th 232, Th-nat, Cm 248, Cf 254, and Fm 256 are not present		9×10^{-5}		3×10^{-6}
If it is known that Sr 90, I 125, I 126, I 129 (I 131, I 133, Table II only) Pb 210, Po 210, Ra 223, Ra 226, Ra 228, Pa 231, Th-nat, Cm 248, Cf 254, and Fm 256 are not present		6×10^{-5}		2×10^{-6}
If it is known that Sr 90, I 129 (I 125, I 126, I 131, Table II only) Pb 210, Ra 226, Ra 228, Cm 248, and Cf 254 are not present		2×10^{-5}		6×10^{-7}
If it is known that (I 129, Table II only) Ra 226 and Ra 228 are not present		3×10^{-6}		1×10^{-7}
If it is known that alpha-emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 241, and Bk 249 are not present	3×10^{-9}		1×10^{-10}	
If it is known that alpha-emitters and Pb-210, Ac 227, Ra 228, and Pu 241 are not present	3×10^{-10}		1×10^{-11}	
If it is known that alpha-emitters and Ac 227 are not present	3×10^{-11}		1×10^{-12}	
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242, Pu 244, Cm 248, Cf 249, and Cf 251 are not present	3×10^{-12}		1×10^{-13}	

4. If the mixture of radionuclides consists of uranium and its daughter products in ore dust prior to chemical processing of the uranium ore, the values specified below may be used in lieu of those determined in accordance with 1., above, or those specified in 2. and 3., above.

a. For purposes of Table I, Col. 1, 1×10^{-10} μc/ml gross alpha activity; or 2.5×10^{-11} μc/ml natural uranium; or 75 micrograms per cubic meter of natural uranium in air.

b. For purposes of Table II, Col. 1, 3×10^{-12} μc/ml gross alpha activity; or 8×10^{-13} μc/ml natural uranium; or 3 micrograms per cubic meter of natural uranium in air.

5. For purposes of this note, a radionuclide may be considered as not present in a mixture if (a) the ratio of the concentration of that radionuclide in the mixture (C_A) to the concentration guide for that radionuclide specified in Table II of this annex (CG_A) does not exceed 1/10, i.e.,

$$\frac{C_A}{CG_A} \leq \frac{1}{10}$$

and (b) the sum of such ratios for all the radionuclides considered as not present in the mixture does not exceed 1/4, i.e.,

$$\frac{C_A}{CG_A} + \frac{C_B}{CG_B} + \ldots \leq \frac{1}{4}$$

6. Conversion from μCi/cc to pCi/m^3 for air and pCi/l for water are as follows:

a. Air—μCi/cc x 10^{12} = pCi/m^3

b. Water—μCi/cc x 10^{9} = pCi/l

7. Concentrations may be derived for unlisted radionuclides provided yearly dose limits in part I, A. and part II, A. are used and the methods are consistent with those recommended by the FRC and ICRP.